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14. ABSTRACT
One of the most important questions in military suicide research at this time is whether deployment in support of Operations Iraqi or Enduring Freedom (OIF/OEF) is associated with an increased risk of suicide. The equivocal research conducted to date on this topic creates a confusing picture for military senior leaders and the American public. The funded study was specifically designed to address many of the recommendations of that report in order to generate seminal results. This collaborative DoD-VA study utilized multiple enterprise level databases to determine whether a history of deployment in support of OIF/OEF is a risk factor for suicide. In addition, the proposed study examined the suicide rates of post-deployed National Guard members and Reservists to determine whether these cohorts are at increased risk of suicide. Furthermore, it examined rates of deaths of undetermined intent in military and civilian populations to determine whether potential misclassifications of deaths may confound military and civilian comparisons of suicide rates. The funded study also specifically examined service members who did not complete a full term of service (e.g., because of misconduct, substance abuse, etc.) and thus may be more likely to have risk factors for suicide. Results have been disseminated through multiple publications and presentations (including a manuscript in press in *JAMA Psychiatry*). In addition, study efforts made a foundational contribution to establishing the DoD/VA Suicide Data Repository, a new enterprise resource for surveillance and research.

15. SUBJECT TERMS
Suicide, Operation Iraqi Freedom (OIF), Operation Enduring Freedom (OEF)

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INTRODUCTION:

One of the most important questions in military suicide research at this time is whether deployment in support of Operations Iraqi or Enduring Freedom (OIF/OEF) is associated with an increased risk of suicide. The equivocal research conducted to date on this topic creates a confusing picture for military senior leaders and the American public. The Report of the Blue Ribbon Workgroup on Suicide Prevention in the Veteran Population (Peake, 2008) reviewed this body of literature and concluded that significant limitations and biases in many of the epidemiological approaches conducted to date contribute to the current confusion. The funded study is specifically designed to address many of the recommendations of that report in order to generate seminal results that will fill what is arguably the most important gap in the epidemiological study of military suicide. This collaborative Department of Defense (DoD) – Veterans Affairs (VA) study utilized multiple enterprise level databases to determine whether a history of deployment in support of OIF/OEF is a risk factor for suicide. In addition, the proposed study examined the suicide rates of post-deployed National Guard members and Reservists to determine whether these cohorts are at increased risk of suicide. Furthermore, it examined rates of deaths of undetermined intent in military and civilian populations to determine whether potential misclassifications of deaths may confound military and civilian comparisons of suicide rates. In examining these suicide rates, the funded study also specifically accounted for the potential confounding effect of service members who did not complete a full term of service (e.g., because of misconduct, substance abuse, etc.) and thus may be more likely to have risk factors for suicide.

BODY:

Scope of Work

This project was conducted across three phases as outlined in the SOW. All objectives are 100% completed. Details of the completion of tasks associated with the two phases of this project are outlined below.

Phase 1. Assembly of Database and Staffing

Task 1. Submit protocol and consent documents to Madigan Army Medical Center Department of Clinical Investigation (DCI) for local IRB review and approval. (Months 1-2)- Completed 100%

Task 2. Acquire software and hardware (Months 1-6). – Completed 100%

Task 3. Hire personnel to install, configure, and manage database (Months 4- 6). Completed 100%

- Recruitment of an Oracle Database Administrator and Website Designer Administrator.
- Complete required staff training (Use of Human Subjects, etc.).
- Complete Crystal reports training for T2 staff.

Task 4. Prepare for data sharing between government agencies (Months 1-18). Completed 100%

- Generate list of military service members from DMDC records
- Submit application to NDI-Plus for data pull (Months 1-2)

- Modify existing data use agreements to provide access to DMDC and MDR

Task 5. Initial data pulls/ merge data (Month27-48). – Completed 100%

- Acquire mortality data from NDI-Plus
- Acquire data from WISQARS
- Determine population sub-groups (Deployed, non-deployed, Active Duty, Guard, Reserve, and Veterans).

Task 6. Prepare Research Progress Report (Months 11-12) Completed 100%

Phase 2. Data Analysis and Reporting (Months 7-60) – Completed 100%

Task 1. Develop and implement data integrity "cleaning" procedures (Month 7). Completed 100%

Task 2. Analyze data to evaluate aims as follows (Months 8-60): - Completed 100%

Aim 1. To compare suicide rates among non-Veterans and service members/Veterans with and without a history of deployment in support of OEF/OIF.

Aim 2. To determine whether active duty and Veteran National Guardsmen and Reservists with a history of OEF/OIF deployment are at increased risk of suicide compared to post-deployed service members/Veterans from the Active component and non-Veterans.

Aim 3. To examine the relationship between suicide rates and rates of deaths of undetermined intent among non-Veterans and Service Members/Veterans with and without a history of deployment in support of OEF/OIF.

Task 3. Prepare Research Progress Report (Months 23-60) Completed 100%

Task 4. Prepare scientific manuscripts for submission to peer reviewed journals. (Months 36-60) – Completed 100%, however additional manuscripts may be written

Objectives and Results

Specific Objectives: 1) compare suicide rates among non-veterans and service members/veterans with and without a history of deployment in support of OIF/OEF; 2) determine whether active duty and veteran National Guard members and Reservists with a history of OIF/OEF deployment are at increased risk of suicide compared to post-deployed service members/veterans from the active component and non-veterans, and; 3) examine the relationship between suicide rates and rates of deaths of undetermined intent among non-veterans and service members/veterans with and without a history of deployment in support of OIF/OEF.

Results Objective 1: Compare suicide rates among non-veterans (civilians) and service members/veterans with and without a history of deployment in support of OIF/OEF

The final cohort included 3,945,099 service members. A total of 31,962 deaths occurred – of which 5,041 were identified as suicides – by December 31, 2009.

Table 1 (see Appendix) displays suicide rate comparisons between Service members (by service) and non-veterans (civilians) from 2002-2009. The adjusted Army suicide rates were lower than civilian rates from 2002-2007 but steadily increased across the observation period and did not differ from the civilian suicide rates from 2007 forward. A similar pattern was observed for the Marine Corps, but some caution is noted in interpreting their results given the broad confidence intervals that resulted. That said, there was no significant difference between the Marines Corps suicide rates and the civilian population in 2003 and then again from 2005 on. The Navy and Air Force also showed steady increases in suicide rates over the same time period. However, the Air Force was lower than the civilian rates for all years. The Navy revealed a sporadic pattern; five out of eight years, their suicide rates were lower than the civilian population.

Table 2 (see Appendix) displays suicide rates for Service members/veterans with and without history of OEF/OIF deployment compared to the civilian population. As shown, both the deployed and non-deployed had lower rates of suicide than the US population for all years except 2009 when both groups had equivalent rates to the US population.

We also calculated suicide rates among Service members according to separation status (not separated versus separated). Results showed that separated Service members' adjusted suicide rates were equivalent to the civilian rates across the observation period with the exception of 2003 (when separated Service members rates were lower). Conversely, adjusted suicide rates for non-separated Service members were lower than the civilian rates across the observation period (see Appendix, Table 3).

Last, we computed the joint effects for deployment and military separation, as shown in Table 4 (see Appendix). We did not observe any differences in the hazard of suicide between those who had deployed and those who had not. This finding was consistent for both specifications of deployment (any or one deployment versus more than one deployment). There was no evidence of effect measure modification as a function of service branch affiliation (any deployment: $\chi^2_{LR} = 0.97$, df = 3, $p = .810$; one versus more than one deployment: $\chi^2_{LR} = 2.04$, df = 6, $p = .916$). We observed a substantial increase in the hazard of suicide as a function of separation from service. In the joint effects model, we observed a small increase in the hazard of suicide associated with deployment prior to separation from service, but it was only marginally statistically significant. For those who had separated from service, the hazard of suicide was high irrespective of deployment history. In contrast to the deployment models, we did observe evidence of heterogeneity by service branch for both the separation from service model ($\chi^2_{LR} = 15.82$, df = 3, $p = .001$) and the joint effects model ($\chi^2_{LR} = 25.45$, df = 9, $p = .003$).

Results Objective 2: Determine whether active duty and veteran National Guard members and Reservists with a history of OIF/OEF deployment are at increased risk of suicide compared to post-deployed service members/veterans from the active component and non-veterans

We tabulated the rate of suicide among Active component Service members and National Guard and Reserve Components after the initiation of their first deployment, adjusting for sex, marital

status, education, race, Service, and rank/grade. There was no difference in suicide rates among Active component Service members and National Guard and Reserve Component Service members (see Appendix; Table 5). Table 6 (see Appendix) displays suicide rates for the Active and Reserve Component Service members and non-veterans (civilian). Although all rates steadily increased over the years, the Reserve component rates were statistically lower than the US population rates for all years. A similar pattern was observed for the Active component with the exception of 2009 when their rate was equivalent to the US rate.

Results Objective 3: Examine the relationship between suicide rates and rates of deaths of undetermined intent among non-veterans and service members/veterans with and without a history of deployment in support of OIF/OEF.

To examine this relationship, data from the cohort were aggregated by year according to age group (17 – 24, 25 – 34, 35 – 44, 45 – 74), race (White or Black/Asian/American Indian), and sex (male or female). Age and racial strata were structured in this manner to allow for sufficient numbers of deaths in each stratum for stable calculation of standardized rates. Data were aggregated for the total cohort and separately within strata of military Service characteristics including Service, Component, separation from Service, and deployment history. Since these characteristics were mutable over time, we partitioned the time at risk in a given year as a function of the calendar date on which the change occurred. Individuals remained at risk in that category until a subsequent change or until death from any cause. Data on military characteristics was available until 31 December 2007 for this cohort. All rates associated with military characteristics for 2008 and 2009 use the last known status as of 31 December 2007. The onset of risk for this cohort, 7 October 2001, coincided with the beginning of deployments in support of Operation Enduring Freedom (OEF). Given the small amount of time for deaths to occur, we did not calculate rates for calendar year 2001.

U.S. population data for deaths by suicide and deaths by means of undetermined intent were accessed from the Web-based Injury Statistics Query and Reporting System (WISQARS) sponsored by the Centers for Disease Control and Prevention (CDC). For each year of 2002 – 2009, we queried data by age category, sex, and race. In the data reporting, the race categories included white, black, Asian/Pacific Islander, and American Indian/Alaskan Native. For correspondence of the cohort data with the data acquired from WISQARS, any cohort members who did not have data that classified them into one of the aforementioned categories were excluded from the current analysis.

For the total cohort, we calculated crude rates of death by suicide or by means of undetermined intent using the number of deaths in each year divided by the number of Service members at risk in each year. We used the direct method to standardize the rates of death in the cohort and the US population to the 2009 US population by age group, race, and sex using data acquired from WISQARS. Standard errors were calculated using the Poisson distribution and we reported the associated 95% confidence intervals of the standardized rates. For the military Service characteristic subgroups, we only report the crude and standardized rates for deaths by suicide. Given the smaller numbers of events and the lack of coverage across all three demographic variables for standardization, we restricted these analyses to males only.

As shown in Table 7 (see Appendix), the suicide rates for the total study cohort versus non-veterans (civilians) revealed a pattern similar to that described earlier – the cohort's suicide rates increased across the observation period and was equivalent to the civilian rate from 2007 to 2009.

The pattern for underdetermined death rates was very similar, although the small number of deaths per year in this category indicates that caution is needed when interpreting the results. Compared to the non-veteran (civilian) rates, adjusted rates for deaths of undetermined intent among the study cohort increased across the observation period but remained lower than the non-veteran (civilian) rates until 2007. The study cohort rates remained equivalent to the US rates in 2008, but dropped below the US rates again in 2009.

Finally, we calculated rates of underdetermined intent among Service members with and without a history of OEF/OIF deployment. These data were uninterpretable due to the low number of deaths in the deployed group, but the data are presented for descriptive purposes (Table 8).

Challenges

The primary challenge we encountered related to regulatory requirements associated with obtaining and linking data from multiple federal organizations. Each organization had their own paperwork format and, given the quantity of data we requested to conduct a truly population-based study, some organizations proceeded extremely cautiously and slowly. Therefore, the timeline we initially projected to obtain the data proved optimistic and a no cost extension was needed to complete the project.

Other Achievements

As a part of the transition and knowledge translation efforts, this project also made a valuable contribution that will provide enduring support for the military suicide surveillance and prevention missions into the future. Specifically, the PI had the opportunity early on in the project to present the methodology from our project to a Health Executive Committee (HEC)/Joint Executive Committee (JEC) sub-workgroup. (The JEC provides senior leadership a forum for collaboration and resource sharing between VA and DoD. The Deputy Secretary of Veterans Affairs and the Under Secretary of Defense for Personnel and Readiness co-chair JEC meetings). The sub-workgroup had been charged with filling some of the suicide data gaps that created barriers for understanding military and veteran suicide. Our project had been specifically designed to provide a comprehensive dataset that provided suicide data from the time personnel enter the military until the end of the observation period, regardless of whether they leave military service or access VA services. The sub-workgroup was excited by the solutions our methods offered. The PI had the opportunity to lead the development of a plan to establish a new DoD/VA Suicide Data Repository that was built on the foundation of our methods. The plan was presented to senior leadership and ultimately implemented.

The DoD/VA Suicide Repository is now led on the DoD side by the Defense Suicide Prevention Office and the PI serves on the Board of Governors. The Repository provides a data solution that links data from military personnel systems (DMDC), the CDC's National Death Index, and VA data systems. One of the risks of the initial grant proposal was that the investigators would complete an important cohort study, but that the benefits of all the work would "die" when the

funding ended. That is, in the future, a similar research team would need to go through a similar process to link these data systems, since the gaps in the overall system would remain. Fortunately, however, the significant effort dedicated to transitioning the methodology to an enduring system has paid off.

The grant offered opportunities for training and professional development for the project coordinators. They were mentored in processes of epidemiological research methods with a particular focus on mortality ascertainment in a large cohort.

KEY RESEARCH ACCOMPLISHMENTS:

- Successfully completed the examination of 3.9 million U.S., military personnel suicide mortality records data
- Addressed long-standing literature gap by providing comprehensive examination of association between deployment and suicide mortality, including analysis of association among OEF/OIF veterans even after military separation
- Dissemination of study information in at least 2 scholarly publications and 4 national conferences
- Study efforts made a foundational contribution to establishing the DoD/VA Suicide Data Repository

REPORTABLE OUTCOMES:

The research team disseminated information about the project and findings at 4 national conferences and in 2 scholarly publications (details below). The data presented via these venues was produced with comprehensive, enterprise level data sources covering the first 7 years of the OEF/OIF conflicts. These data were aggregated and analyzed with the highest level of methodological rigor. As a result, these data informed long-standing and much debated questions about the role of deployment to OEF/OIF in military suicide, which has been of utmost concern among senior leadership, the broader military community, and American public.

<u>In-press publications</u>:

Reger, M.A., Smolenski, D.J., Skopp, N.A., Metzger-Abamukang, M.J., Kang, H.K., Bullman, T.A.,Gahm, G.A. (in press). Risk of suicide following OEF/OIF deployment and separation from the US military. *JAMA Psychiatry.*

Kang, H. K., Bullman, T. A., Smolenski, D. J., Skopp, N. A., Gahm, G. A., Reger, M. A. (In Press).Suicide Risk among 1.3 Million Veterans Who Were on Active Duty During the Iraq and Afghanistan Wars. Annals of Epidemiology.

<u>Publications In Progress:</u>

Skopp, N.A., Smolenski, D.J., Schwesinger, D.A., Johnson, C.J., Metzger-Abamukang, M.J., & Reger, M. (2015) *Evaluation of a Methodology to Validate National Death Index Retrieval Results among a Cohort of U.S. Service Members.*

<u>Presentations</u>:

Smolenski, D.J. (2014/December). Time-to-event analysis of suicide following OEF/OIF. AMSUS. The Society of Federal Health Professionals Annual Meeting, December 2-5,

2014, Washington DC.

Reger, M., Smolenski, D., Skopp, N., Metzger-Abamukang, M., Kang, H., Bullman, T., et al. (2014, August). The Association between Suicide and OIF/OEF Deployment History. 2014 Military Health System Research Symposium. Fort Lauderdale, FL.

Reger, M. A., Skopp, N. A., Schwesinger, D., Metzger-Abamukang, M., Smolenski, D., Kang, H., Bullman, T., Gahm, G. A. (2012, June).A suicide study to fill key epidemiological gaps: Linking national death index data with military personnel data. Presented at the DoD/VA Suicide Prevention Conference. Washington, DC.

Reger, M. A., Skopp, N. A., Schwesinger, D., Metzger-Abamukang, M., Smolenski, D., Kang, H., Bullman, T., Gahm, G. A. (2012, August). The association between suicide and OIF/OEF deployment history. Paper presented at The 2012 Military Health System Research Symposium, Fort Lauderdale, FL.

Other

Skopp, N.A., Smolenski, D.J., Schwesinger, D.A., Johnson, C.J., Metzger-Abamukang, M.J., & Reger, M. (2015) *Evaluation of a Methodology to Validate National Death Index Retrieval Results among a Cohort of U.S. Service Members.*

CONCLUSION:

This project examined the association between deployment and suicide mortality with comprehensive, enterprise level data that included all 3.9 million U.S., military personnel who served during first 7 years of the OEF/OIF conflicts and included an examination of this association among OEF/OIF veterans even after military separation. This project represents the most comprehensive examination of this topic to date, and it was specifically designed to address long-standing gaps in this literature that were identified by the VA Blue Ribbon Report (Peake, 2008). As such, it has filled a significant gap in the literature and helped to resolve equivocal findings reported in earlier research. The fact that some of the results were accepted for publication in *JAMA Psychiatry* supports the seminal nature of the project. We appreciated the comments of one of our peer-reviewers during the review process who commented that our study was "the first truly population-based report of suicide risk in recent US military service members after they have separated from military service." We expect forthcoming publications to generate significant leadership and media interest. The fundamental finding that deployment, overall, is not associated with suicide is an important fact that contradicts general thinking among some leaders and the US public. It is essential to correct this assumption. In addition, several other findings have potential prevention and policy implications that will help aid the fundamental goal of saving lives.

As a part of the transition and knowledge translation efforts, this project also made a foundational contribution to establishing the DoD/VA Suicide Data Repository (see above in Other Accomplishments). This new enterprise system is "live," and dozens of researchers have already accessed the Suicide Data Repository data for projects that otherwise would not have been possible. Our project was instrumental in the development of the DoD/VA joint Suicide Data Repository, a premier VA/DoD epidemiological resource that is now available to researchers at no cost.

This project accomplished its mission to promote and support the advancement of military medicine and specifically military medical research. The results of this project provide comprehensive scientific findings that advance public knowledge of military suicide. There has been a widespread, long-standing belief that the escalation in suicide rates among Service members and veterans is attributable to deployment to OEF/OIF. Our research does not support that relationship. Rather our research results showed that early military separation and "other than honorable" discharge relate to increased suicide mortality risk. The results of this research have enriched the scientific and clinical knowledge base on associations between deployment and suicide.

REFERENCES

Peake J.B. *The Blue Ribbon Work Group of Suicide Prevention in the Veteran Population. Chartered by Secretary of Veterans Affairs James B. Peake, May 5, 2008.*

APPENDICES

Table 1. Crude and standardized rates of death by suicide, 2002 – 2009, among male Service members, by Service

Year	Deaths	Rate[a]	Rate[b]	95% CI	US Rate[b]
			Army		
2002	97	10.13	7.93	5.69, 10.17	22.04
2003	171	16.24	11.49	9.20, 13.78	21.85
2004	207	18.06	16.10	12.99, 19.21	21.95
2005	261	21.20	16.99	14.22, 19.75	21.95
2006	290	21.80	18.24	15.39, 21.08	22.26
2007	360	25.10	20.60	17.75, 23.45	22.91
2008[c]	418	28.24	22.01	19.31, 24.72	23.76
2009[c]	413	27.94	22.54	19.79, 25.29	23.99
			Air Force		
2002	39	8.55	8.03	4.84, 11.22	22.04
2003	68	13.80	12.37	8.80, 15.94	21.85
2004	83	15.76	13.33	9.95, 16.71	21.95
2005	76	13.80	12.10	8.95, 15.26	21.95
2006	97	16.77	16.70	12.91, 20.49	22.26
2007	113	18.66	16.40	13.02, 19.78	22.91
2008[c]	109	17.65	16.92	13.42, 20.42	23.76
2009[c]	123	19.93	18.64	15.00, 22.28	23.99
			Marine Corps		
2002	25	10.92	8.79	1.01, 16.57	22.04
2003	49	18.80	14.59	3.10, 26.08	21.85
2004	74	25.41	12.80	7.21, 18.38	21.95
2005	73	22.65	22.33	10.22, 34.45	21.95
2006	77	21.88	16.95	8.11, 25.79	22.26
2007	97	25.33	19.60	10.62, 28.58	22.91
2008[c]	109	27.27	18.00	10.76, 25.24	23.76
2009[c]	130	32.56	28.80	18.54, 39.05	23.99
			Navy		
2002	47	10.98	10.53	5.91, 15.16	22.04
2003	80	17.24	16.67	11.34, 22.01	21.85
2004	82	16.44	15.18	10.51, 19.85	21.95
2005	90	16.96	13.83	10.01, 17.65	21.95
2006	95	16.93	17.73	13.09, 22.38	22.26
2007	103	17.45	15.54	11.69, 19.39	22.91
2008[c]	122	20.20	17.59	13.64, 21.54	23.76
2009[c]	130	21.54	20.98	16.61, 25.34	23.99

Note: CI = confidence interval.

[a]Crude rate, per 100,000 persons

[b]Rate, per 100,000 persons, directly standardized to the 2009 US population by age (17-24, 25-34, 35-44, 45-74) and race (White, Black/Asian/American Indian).

[c] Service affiliation for these years based on last known status as of 31 December 2007.

Table 2. Crude and standardized rates of death by suicide, 2002 – 2009, among male Service members, by OEF/OIF deployment history

Year	Deaths	Rate[a]	Rate[b]	95% CI	US Rate[b]
			No deployment history		
2002	201	9.97	8.57	6.87, 10.27	22.04
2003	326	16.46	13.05	11.11, 15.00	21.85
2004	365	18.65	15.44	13.31, 17.57	21.95
2005	393	20.36	16.46	14.36, 18.55	21.95
2006	402	20.56	17.91	15.66, 20.16	22.26
2007	444	21.73	18.18	16.02, 20.34	22.91
2008[c]	527	24.86	19.81	17.69, 21.93	23.76
2009[c]	558	26.36	22.02	19.81, 24.23	23.99
			One or more deployments		
2002	7	12.81	6.52	1.61, 11.44	22.04
2003	42	14.47	12.74	5.66, 19.82	21.85
2004	81	16.02	14.38	9.03, 19.73	21.95
2005	107	15.20	11.87	8.43, 15.30	21.95
2006	157	18.11	17.74	13.60, 21.88	22.26
2007	229	23.60	19.25	15.72, 22.79	22.91
2008[c]	231	23.52	20.24	16.78, 23.71	23.76
2009[c]	238	24.26	21.53	17.84, 25.23	23.99

Note: CI = confidence interval; OEF = Operation Enduring Freedom; OIF = Operation Iraqi Freedom.

[a]Crude rate, per 100,000 persons

[b]Rate, per 100,000 persons, directly standardized to the 2009 US population by age (17-24, 25-34, 35-44, 45-74) and race (White, Black/Asian/American Indian).

[c]Deployment history for these years based on last known status as of 31 December 2007.

Table 3. Crude and standardized rates of death by suicide, 2002 – 2009, among male Service members, by separation status

Year	Deaths	Rate[a]	Rate[b]	95% CI	US Rate[b]
			Not separated		
2002	185	9.23	8.13	6.43, 9.82	22.04
2003	268	12.97	10.69	8.85, 12.53	21.85
2004	325	15.54	13.77	11.59, 15.95	21.95
2005	310	15.04	12.95	10.88, 15.02	21.95
2006	335	16.42	16.50	13.96, 19.05	22.26
2007	393	19.63	16.92	14.48, 19.36	22.91
2008[c]	432	21.92	18.78	16.27, 21.29	23.76
2009[c]	463	23.52	19.69	17.29, 22.09	23.99
			Separated from Service		
2002	23	34.31	22.40	10.29, 34.50	22.04
2003	100	49.19	34.73	26.38, 43.08	21.85
2004	121	32.55	23.40	18.45, 28.35	21.95
2005	190	33.13	25.58	21.49, 29.66	21.95
2006	224	28.64	24.05	20.47, 27.63	22.26
2007	280	27.69	22.73	19.65, 25.82	22.91
2008[c]	326	28.83	24.94	21.83, 28.04	23.76
2009[c]	333	29.50	26.34	22.96, 29.73	23.99

Note: CI = confidence interval.

[a]Crude rate, per 100,000 persons

[b]Rate, per 100,000 persons, directly standardized to the 2009 US population by age (17-24, 25-34, 35-44, 45-74) and race (White, Black/Asian/American Indian).

[c] Separation from Service for these years based on last known status as of 31 December 2007.

Table 4. Associations between deployment in support of Operation Enduring Freedom (OEF) or Operation Iraqi Freedom (OIF) and separation from service between 2001 – 2007 with suicide (2001 – 2009) for all service members

Variable	No. suicides	Person-years	Rate[a]	HR[b]	99% CI	HR[c]	99% CI
Any deployment							
No	3,879	21,813,395	17.78		Ref.		Ref.
Yes	1,162	6,160,021	18.86	0.97	0.89, 1.06	0.96	0.87, 1.05
One deployment	895	4,819,854	18.57	0.97	0.88, 1.06	0.94	0.85, 1.04
More than one deployment	267	1,340,168	19.92	1.00	0.85, 1.18	1.03	0.87, 1.22
Separation from service							
No	3,106	20,547,043	15.12		Ref.		Ref.
Yes	1,935	7,426,373	26.06	1.60	1.48, 1.73	1.63	1.50, 1.77
Joint effects of deployment and separation							
No deployment, no separation	2,199	15,349,998	14.33		Ref.		Ref.
Deployment, no separation	907	5,197,045	17.45	1.14	1.02, 1.27	1.10	0.99, 1.23
No deployment, separation	1,680	6,463,397	25.99	1.68	1.53, 1.83	1.69	1.54, 1.85
Deployment, separation	255	962,976	26.48	1.65	1.38, 1.97	1.59	1.33, 1.91

[a] Rate per 100,000 person-years
[b] Unadjusted
[c] Adjusted for baseline demographic and service covariates: age, sex, race/ethnicity, education, and service branch. Time-dependent covariates included rank and Component affiliation prior to separation from service.
[d] Models for separation from service used last known marital status, rank, and Component affiliation prior to separation.

Table 5. Rate of suicide among Service members after the date of initiation of their first deployment and comparison of rates by Component affiliation

Component	Suicides	PY	Rate[a]	HR[b]	99% CI	HR[c]	99% CI
Active	710	3,785,707	18.75	Ref.			
Reserve/National Guard	452	2,374,315	19.04	0.97	0.83, 1.14	0.87	0.74, 1.02

Note: PY = person-years; HR = hazard ratio; CI = confidence interval.
[a]Per 100,000 person-years
[b]Unadjusted
[c]Adjusted for sex, marital status, education, race, Service, and rank/grade.

Table 6. Crude and standardized rates of death by suicide, 2002 – 2009, among male Service members, by Component

Year	Deaths	Rate[a]	Rate[b]	95% CI	US Rate[b]
			Active Component		
2002	158	12.42	11.19	8.07, 14.31	22.04
2003	243	17.71	13.63	10.71, 16.56	21.85
2004	266	18.22	12.53	10.13, 14.93	21.95
2005	289	18.91	15.08	12.48, 17.69	21.95
2006	324	20.10	17.48	14.60, 20.36	22.26
2007	380	22.43	16.40	14.08, 18.73	22.91
2008[c]	459	26.52	20.99	18.34, 23.65	23.76
2009[c]	483	27.94	22.11	19.50, 24.72	23.99
			Reserve and National Guard Components		
2002	50	6.26	5.98	4.02, 7.93	22.04
2003	125	13.92	12.06	9.55, 14.58	21.85
2004	180	17.95	17.12	14.12, 20.12	21.95
2005	211	19.07	15.60	13.09, 18.11	21.95
2006	235	19.42	17.87	15.11, 20.62	22.26
2007	293	22.21	19.99	17.21, 22.76	22.91
2008[c]	299	21.81	18.40	15.92, 20.87	23.76
2009[c]	313	22.87	20.88	18.16, 23.61	23.99

Note: CI = confidence interval.

[a]Crude rate, per 100,000 persons

[b]Rate, per 100,000 persons, directly standardized to the 2009 US population by age (17-24, 25-34, 35-44, 45-74) and race (White, Black/Asian/American Indian).

[c] Component affiliation for these years based on last known status as of 31 December 2007.

Table 7. Crude and standardized rates of death by suicide, 2002 – 2009, for the total cohort

Year	Deaths	Rate[a]	Rate[b]	95% CI	US Rate[b]
			Suicide		
2002	218	8.87	6.65	4.31, 9.00	13.66
2003	389	14.38	9.08	6.94, 11.22	13.56
2004	474	16.11	11.05	8.66, 13.43	13.83
2005	530	16.82	10.41	8.57, 12.25	13.74
2006	599	17.72	11.83	10.13, 13.53	14.00
2007	707	19.56	12.47	10.48, 14.47	14.47
2008	802	21.54	13.30	11.43, 15.17	14.94
2009	841	22.61	14.35	12.53, 16.17	15.13
			Undetermined intent		
2002	16	0.65	0.35	0.07, 0.63	2.15
2003	33	1.22	0.69	0.33, 0.93	2.28
2004	17	0.58	0.35	0.13, 0.58	2.18
2005	36	1.14	0.87	0.00, 1.73	2.04
2006	52	1.54	1.18	0.36, 2.01	2.20
2007	59	1.63	1.64	0.60, 2.69	2.31
2008	53	1.42	1.45	0.50, 2.39	2.12
2009	65	1.75	1.03	0.70, 1.36	2.06

Note: CI = confidence interval.

[a]Crude rate, per 100,000 persons

[b]Rate, per 100,000 persons, directly standardized to the 2009 US population by age (17-24, 25-34, 35-44, 45-74), race (White, Black/Asian/American Indian), and sex (male, female).

Table 8. Crude and standardized rates of death by means of undetermined intent, 2002 – 2009, among male Service members, by OEF/OIF deployment history

Year	Deaths	Rate[a]	Rate[b]	95% CI	US Rate[b]
			No deployment history		
2002	15	0.74	0.49	0.16, 0.81	2.85
2003	29	1.46	1.16	0.58, 1.07	3.03
2004	15	0.77	0.81	0.28, 0.81	2.84
2005	30	1.55	1.00	0.56, 1.43	2.51
2006	40	2.05	1.54	0.94, 2.15	2.83
2007	38	1.86	1.34	0.81, 1.86	2.93
2008[c]	37	1.75	1.71	1.01, 2.41	2.68
2009[c]	40	1.89	1.71	1.07, 2.35	2.58
			One or more deployments		
2002	0	0.00	0.00	--	2.85
2003	2	0.69	0.29	0.00, 0.69	3.03
2004	2	0.40	0.17	0.00, 0.40	2.84
2005	4	0.57	0.30	0.00, 0.60	2.51
2006	8	0.92	0.54	0.16, 0.92	2.83
2007	13	1.34	1.07	0.29, 1.85	2.93
2008[c]	10	1.02	0.49	0.15, 0.82	2.68
2009[c]	21	2.14	1.74	0.70, 2.78	2.58

Note: CI = confidence interval; OEF = Operation Enduring Freedom; OIF = Operation Iraqi Freedom.

[a]Crude rate, per 100,000 persons

[b]Rate, per 100,000 persons, directly standardized to the 2009 US population by age (17-24, 25-34, 35-44, 45-74) and race (White, Black/Asian/American Indian).

[c]Deployment history for these years based on last known status as of 31 December 2007.

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Original article

Suicide risk among 1.3 million veterans who were on active duty during the Iraq and Afghanistan wars

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ABSTRACT

Purpose: We conducted a retrospective cohort mortality study to determine the postservice suicide risk of recent wartime veterans comparing them with the US general population as well as comparing deployed veterans to nondeployed veterans.

Methods: Veterans were identified from the Defense Manpower Data Center records, and deployment to Iraq or Afghanistan war zone was determined from the Contingency Tracking System. Vital status of 317,581 deployed and 964,493 nondeployed veterans was followed from the time of discharge to December 31, 2009. Underlying causes of death were obtained from the National Death Index Plus.

Results: Based on 9353 deaths (deployed, 1650; nondeployed, 7703), of which 1868 were suicide deaths (351; 1517), both veteran cohorts had 24% to 25% lower mortality risk from all causes combined but had 41% to 61% higher risk of suicide relative to the US general population. However, the suicide risk was not associated with a history of deployment to the war zone. After controlling for age, sex, race, marital status, branch of service, and rank, deployed veterans showed a lower risk of suicide compared with nondeployed veterans (hazard ratio, 0.84; 95% confidence interval, 0.75–0.95). Multiple deployments were not associated with the excess suicide risk among deployed veterans (hazard ratio, 1.00; 95% confidence interval, 0.79–1.28).

Conclusions: Veterans exhibit significantly higher suicide risk compared with the US general population. However, deployment to the Iraq or Afghanistan war, by itself, was not associated with the excess suicide risk.

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Introduction

The reported increased risk of suicide among recent US military veterans, particularly those who have served in either the Afghanistan or Iraq War, has been of concern among veterans, the public and policy makers. The US Department of the Army reported that the suicide rates in soldiers almost doubled between 2005 and 2009 [1]. Before the Iraq and Afghanistan wars, the suicide rates among active duty and former military personnel had been 20% to 30% lower than that of US general population, adjusting for difference in demographic composition by gender, age, and race [2–5].

The recent wars in Iraq and Afghanistan are substantially different from prior wars in Vietnam (1965–1973) or the Persian Gulf (1990–1991). Recent war veterans had been deployed repeatedly and for a longer tour than those from previous wars. The types of warfare and injuries sustained by today's troops are also different than those seen in previous wars [6]. Today's military service members are all volunteers, older, and more likely to be married with children. Women make up a greater percentage of service members than their Vietnam-era counterparts as well. Although many postservice health issues of female veterans are likely to mirror those of male veterans, there may be gender specific mental health consequences of military service and battlefield deployment [7].

There have been several studies that compare suicide risk between those who were deployed in Iraq or Afghanistan and those who were not deployed. A few studies reported no higher risk among service members with a history of deployment than others who were not deployed [1,8,9], whereas another recent study suggested elevated suicide risk among currently and previously deployed soldiers [10]. Among veteran patients receiving care at U.S. Department of Veterans Affairs (VA) medical facilities, the

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suicide rate for Iraq and Afghanistan veteran patients was not significantly different than other veteran patients when adjusted for their psychiatric conditions and demographic variables (age, sex, and geographic region) [11].

There has not been a large population-based cohort study that compares post service suicide risk between Iraq and Afghanistan war veterans and contemporary veterans who were not deployed. It has been reported that those who remained in service after deployment are believed to be healthier than those who were discharged [12]. Therefore, a study of postservice suicide risk among veterans would complement a study of military population still on active duty and may elucidate longer term health consequences of wartime service in Iraq and Afghanistan.

Given that many returning veterans screened positive for a mental disorder [13–15], and that certain mental disorders, especially the presence of major depressive disorder and posttraumatic stress disorder (PTSD), are significant risk factors for suicide and/or suicidal behavior [9,16–19]; we attempted to determine whether or not (1) the postservice suicide risk among recent military veterans is similar to that of US population; and whether or not (2) risk of suicide among Iraq and Afghanistan war veterans is similar to that of veteran peers who were not deployed. To this end, we conducted a postservice mortality study of all former active component service members who were discharged from the military service through 2007.

Methods

Study participants

Study subjects were identified from 4.1 million individuals who served in the US military from 2001 to 2007. Among these, 1,282,074 served with an active component unit and separated from active duty before the end of 2007. Deployment to Iraq or Afghanistan war theater was determined from the Defense Manpower Data Center Contingency Tracking System records and defined by service location in Iraq, Afghanistan, and surrounding countries or waterways (the Red Sea, the Gulf of Aden, the Gulf of Oman, and the Arabian Sea).

The Defense Manpower Data Center provided electronic personal records of these service members. Service information on the records included service branch, unit component, service dates, deployment locations and dates, and rank. Demographic information on the records included birth date, gender, race/ethnicity, and marital status.

Determination of vital service and cause of death data collection

Vital status of each veteran after his/her discharge from active duty was determined by matching social security numbers of the veterans with the Social Security Administration Death Master File and the National Center for Health Statistics National Death Index (NDI) [20]. The follow-up period ended at either the veteran's date of death or on December 31, 2009, whichever came earlier. Underlying cause of death information was obtained from the NDI Plus. The NDI Plus is a service available since 1997, in which National Center for Health Statistics provides cause-of-death codes using the *International Classification of Diseases, Ninth Revision or Tenth Revision* [21,22].

Statistical analysis

Crude suicide rates were computed by dividing observed suicide numbers by person-years at risk of dying per 100,000 persons. Person-years at risk were counted beginning at separation from active duty and ending on death or December 31, 2009, whichever came first. The National Institute for Occupational Safety and Health Life Table Analysis System version 3.0.3, software was used to obtain standardized mortality ratios (SMRs) and 95% confidence intervals (CIs) for each cause-of-death category [23]. The SMR is the ratio of the observed deaths among veterans to the expected deaths calculated from the mortality rates for the US general population (referent population) adjusted for gender, race, age, and calendar period.

Multivariable Cox proportional hazards regression was used to obtain hazard ratio (HR) and 95% CI for suicide associated with deployment, accounting for possible confounding and the effect of selected covariates [24]. The covariates considered in the model were age at the start of follow-up, race, gender, marital status, service branch (Army, Marines/Air Force, and Navy), and rank (enlisted/officer). Among the deployed veterans, HR and 95% CI were calculated for suicide associated with multiple deployment. There had to be at least 30 days of interval between deployments for a deployment to be considered unique.

Analyses were also repeated for male and female veterans separately because female veterans may have had different experiences than male counterparts during their battlefield deployment or postservice readjustment to civilian life.

The Cochran–Armitage trend test was conducted to look for trends in suicide rates associated with years since being discharged from military service for both deployed and nondeployed veterans [25].

Except for the Life Table Analysis System software output, the estimates and procedures described in this article were generated by using Statistical Analysis software, version 9.3 Cary, NC [24]. Two-tailed statistical tests were conducted. Any SMRs and HRs for which 95% CIs did not include 1.00 were considered statistically significant.

The Washington VA Medical Center Institutional Review Board and Madigan Medical Center Institutional Review Board approved this study.

Results

Characteristics of deployed and nondeployed veteran cohorts

The demographic and military characteristics of the deployed veterans were somewhat different than the nondeployed veteran counterparts. Deployed veterans were slightly younger, included fewer women, fewer nonwhites, and fewer nonmarried. A larger portion of deployed veterans served with the Army and Marine Corps units and conversely, fewer with the Navy (Table 1).

Among the 317,581 deployed veterans, 1650 died through the end of follow-up on December 31, 2009. Of these deaths, 351 were from suicides. Likewise, among the 964,493 nondeployed veterans, 7703 died and 1517 were from suicides. Cause of death information was available for 94% of the deployed and 96% of nondeployed veteran deaths (Table 2).

Veteran suicide risk compared to US general population

Among nondeployed veterans, overall mortality risk was significantly lower (SMR, 0.76; 95% CI, 0.74–0.78) and suicide risk was significantly higher (SMR, 1.61; 95% CI, 1.53–1.69) than comparable US general population. Likewise, although overall mortality risk was 25% lower (SMR, 0.75; 95% CI, 0.71–0.79), suicide risk was 41% higher among deployed veterans (SMR, 1.41; 95% CI, 1.26–1.56). Comparing suicide rates between male and female veterans, female rate was about a third that of male veterans (male, 33.4/100,000; female, 11.2/100,000). However, in comparison with their respective US gender-specific population, the magnitude of suicide risk

Table 1
Demographic and military characteristics of veterans who were on active duty in the US Armed Forces, 2001 to 2007

Demographic characteristics	Deployed veterans (n = 317,581)	Nondeployed veterans (n = 964,493)
	Number (%)	Number (%)
Year born		
LE 1966	42,693 (13.4)	211,919 (22.0)
1967–1977	76221 (24.0)	230,922 (23.9)
1978–1981	103,719 (32.6)	266,635 (27.7)
1982–1990	94,948 (30.0)	255,017 (26.4)
Mean age at entry	28.7	29.2
Sex		
Male	281,114 (88.5)	777,571 (80.6)
Female	36,467 (11.5)	186,922 (19.4)
Race		
White	248,375 (78.2)	725,117 (75.2)
Nonwhite	69,206 (21.8)	239,376 (24.8)
Marital status*		
Married	163,053 (51.3)	469,036 (48.6)
Not married	154,528 (48.7)	495,457 (51.4)
Year of discharge		
2001	5202 (1.6)	119,373 (12.4)
2002	7777 (2.5)	123,728 (12.8)
2003	18,703 (5.9)	124,595 (12.9)
2004	42,276 (13.3)	141,018 (14.6)
2005	63,026 (19.9)	151,653 (15.7)
2006	81,431 (25.6)	150,007 (15.5)
2007	99,166 (31.2)	154,119 (16.0)
Branch of service†		
Army	170,206 (53.6)	326,327 (33.8)
Marines	61,065 (19.2)	130,054 (13.5)
Air force	62,263 (19.6)	207,473 (21.5)
Navy	24,047 (7.6)	300,633 (31.2)
Missing	0	6
Rank†		
Enlisted	281,237 (88.6)	863,941 (89.6)
Officer	36,344 (11.4)	100,552 (10.4)

* Last recorded through end of 2007. Not Married category includes single, divorced, and separated individuals.
† Last recorded through end of 2007.

was higher among female veterans (SMR: deployed, 2.19; nondeployed, 2.36) than male veterans (SMR: deployed, 1.38; nondeployed, 1.57) regardless of their deployment status (Table 3).

Effects of deployment on the suicide risk

HRs derived from the Cox proportional hazards model for male and female veterans are shown in Table 4. After controlling for potential confounders (age, sex, race, marital status, and military service variables such as branch and rank), the deployed veterans had a lower risk of suicide compared with nondeployed veterans (HR, 0.84; 95% CI, 0.75–0.95). Male deployed veterans had a significantly lower risk of suicide than other male nondeployed veterans (HR, 0.83; 95% CI, 0.74–0.94), whereas no deployment effect was observed in female veterans (HR, 0.99; 95% CI, 0.57–1.71). In both male and female veteran groups, the suicide risk was higher among younger, white, unmarried, enlisted, and Army/Marine veterans (Table 4).

Table 2
Numbers of postservice deaths and suicides and mortality rates (per 100,000 person-years) by gender, branch, and deployment status of veterans, 2001 to 2009

Categories	Deployed veterans		Nondeployed veterans	
	Number of deaths	Rate/100,000 person-years	Number of deaths	Rate/100,000 person-years
All deaths	1650	131.2	7703	151.6
Male	1582	142.1	6965	169.2
Female	68	47.1	738	76.5
Suicide	351	27.9	1517	29.9
Male	336	30.1	1408	34.2
Female	15	10.4	109	11.3
Army	209	30.0	586	32.0
Air Force	53	21.5	263	24.5
Marine	66	30.2	248	37.8
Navy	23	23.8	420	27.6

Table 3
All-cause mortality and suicide risk of veterans compared with the US population by gender and deployment status of veterans

Categories	Deployed veterans		Nondeployed veterans	
	SMR	95% CI	SMR	95% CI
All veterans				
All causes	0.75	0.71–0.79	0.76	0.74–0.78
Suicide	1.41	1.26–1.56	1.61	1.53–1.69
Male veterans				
All causes	0.76	0.72–0.80	0.76	0.74–0.77
Suicide	1.38	1.24–1.54	1.57	1.49–1.65
Female veterans				
All causes	0.56	0.44–0.71	0.82	0.76–0.88
Suicide	2.19	1.22–3.61	2.36	1.94–2.85

Suicide rates as function of the length of time since discharge

In both deployed and nondeployed veterans, the suicide rate was the highest during the first 3 years after leaving military service (deployed veterans, 29.7; nondeployed veterans, 33.1). The rates decreased over the next two 3-year periods. This trend was statistically significant for nondeployed veteran cohorts (Z = 3.92, P < .001). Among the deployed veterans, the suicide risk was not significantly different between those who were deployed once and those who were deployed multiple times (HR, 1.00; 95% CI, 0.79–1.28) (Table 5).

Discussion

Many health studies of veterans of two prior war periods, Vietnam era and Gulf War era, showed that the risks of overall mortality and suicide were significantly lower among veterans than those of the US general population irrespective of their place of service [2–5,26–28]. The present study also supports these earlier findings in that mortality risk from all-causes combined was 25% lower in deployed veterans (SMR, 0.75; 95% CI, 0.71–0.79) and 24% lower in nondeployed veterans (0.76; 0.74–0.78) compared with the US general population.

This lower mortality risk has been attributed to the "healthy soldier effect," similar to the healthy worker effect. A veteran population during the earlier years of separation from active duty is

Table 4
Hazard ratios (95% CI) associated with potential suicide risk factors among male and female veterans

Potential risk factors	HR (95% CI)		
	Male veterans (1744 suicides)	Female veterans (124 suicides)	All veterans (1868 suicides)
Deployment (Y/N)	0.83 (0.74–0.94)	0.99 (0.57–1.71)	0.84 (0.75–0.95)
Sex (male/female)	—	—	3.12 (2.60–3.74)
Race (white/other)	1.44 (1.27–1.64)	1.40 (0.94–2.10)	1.43 (1.27–1.62)
Army/marines (Y/N)	1.08 (0.98–1.19)	1.37 (0.95–1.97)	1.10 (1.00–1.21)
Marital status (unmarried/others)	1.27 (1.13–1.42)	1.77 (1.19–2.65)	1.30 (1.17–1.45)
Age (y)	0.95 (0.94–0.96)	0.97 (0.94–0.99)	0.96 (0.95–0.96)
Rank (E/O)	1.92 (1.48–2.48)	1.91 (0.75–4.85)	1.91 (1.50–2.45)

Table 5
Suicide rate by year since discharge by deployment status of veterans

Years since discharge	Deployed veterans*		Nondeployed veterans*	
	Suicides	Rate/100,000	Suicides	Rate/100,000
<3	232	29.7	788	33.1
3 to <6	106	24.7	542	27.3
6 to <9	13	26.1	187	25.6
Total	351	27.9	1517	29.9

* Cochran–Armitage trend test: deployed veterans, $Z = 1.445$, $P > .05$; nondeployed veterans, $Z = 3.928$, $P < .001$.

believed to be healthier than the US general population because of the initial physical screening for military service, requirements to maintain certain standards of physical fitness and better access to medical care during and after military service.

What is remarkably different among these recent wartime veterans is that this "healthy soldier effect," unlike for the previous wartime veterans, did not render a positive effect on the risk of suicide. The risk of suicide among recent wartime veterans was significantly higher (41% and 61%) than that of the US general population. We reported a similar finding earlier from a study of 212,664 former active component service personnel of Iraq and Afghanistan wars. Suicide risk of these veterans as of December 31, 2005, was 33% higher than that of the US population (SMR, 1.33; 95% CI, 1.03–1.69) [29].

Rising suicide rates during the period of 2002 to 2009 among active duty military personnel, especially those who were in the Army and Marine Corps, have been reported in official Department of Defense reports [1,8]. Although the rates among Navy and Air Force personnel were still significantly below civilian rates, the rates for active duty soldiers in the Army and Marine Corps surpassed the rates for comparable civilian peers in 2008 (Army, 20.2 vs. civilians, 19.2) reaching a peak rate of 23 to 25 per 100,000 in 2009. Two recent studies also demonstrated that veterans, both males and females, were more likely to die of suicide than their nonveteran counterparts [30,31].

It has been a generally accepted belief that the steady rise in suicide rate in military personnel since the start of wars in Afghanistan and Iraq could be in part attributable to physical and mental stressors associated with their deployment. Indirect evidence of possible pathways from deployment exposure to increased suicide risk arises from a link between combat exposure and PTSD and observations of increased suicide risk among veterans with PTSD. It has been reported that the rates of PTSD among war veterans were proportional to the degree of combat experience they had [32]. Also, when comparing war veterans with PTSD to those without PTSD, veterans with PTSD had significantly higher rates of suicide [33,34], suicide attempts [35], and suicidal ideation [19]. However, there are other studies that do not support an association between PTSD and increased suicide risk. A recent study of Veterans Health Administration patients showed that PTSD was associated with decreased risk for suicide after adjusting for other mental disorders [36]. Also, a meta-analysis of literature that report on PTSD and suicide risk indicated that while PTSD was associated with an increased incidence of prior attempted suicide and prior and current suicidal ideation, it was not associated with an increased risk of completed suicide [37].

The present study found that deployment to the war zone by itself did not contribute to the excess suicides in veterans. After controlling for age, sex, race, marital status, and military service variables such as branch and rank, the deployed veterans had a lower risk of suicide compared with nondeployed veterans. In keeping with known demographic risk factors for suicide in civilians, the suicide risk was higher among younger, male, white, and unmarried veterans. The risk was also higher among enlisted and Army/Marine veterans. The risk factors associated with suicide were similar between male and female veterans.

Some studies reported similar findings of no significant association between war zone deployment and excess suicide [1,9,11]. In one of these studies, none of the Iraq and Afghanistan deployment-related factors (self-reported combat experience, cumulative days deployed, or number of deployments) were associated with the excess suicide risk [9]. However, another study of active duty Army soldiers indicated an elevated suicide risk among currently and previously deployed soldiers [10]. In the present study, not only was there no excess suicide among the deployed compared with the nondeployed veterans, there was no significant difference in suicide risk between those deployed only once and those who were deployed multiple times. Had there been an increased suicide risk among veterans with multiple deployments compared with those with one tour, it would have been consistent with a possibility of association between deployment history and suicide in a subgroup of deployed veterans who were likely to have had a greater deployment related experience.

The underlying reasons for the excess suicide rates among the new generation of both deployed and nondeployed veterans compared with the US general population were not explored in this study. However, one may speculate that the recent protracted wars in Iraq and Afghanistan could have attracted more young adult volunteers who may have a higher level of risk taking behaviors. Also, economic stress associated with transition to civilian life and employment difficulties following the transition could have all contributed to family relationship and readjustment problems. One could also speculate that some veterans having adopted the military culture where mental toughness is seen as a sign of strength may have avoided seeking help from mental health professionals and others. Substance abuse among recent veterans stemming from military life could also be a factor in the excess suicide risk. A recent study of 83 suicides among 151,560 US military personnel confirmed that having mental conditions such as depression, binge drinking, or having alcohol-related problems are risk factors for suicide [9]. Another plausible explanation that the rise in the Army suicide rate since 2004 could be associated with concomitant increase in accession waivers for new Army recruits was not supported in the Army Study to Assess Risk and Resilience in Servicemembers [10].

Serious flaws in the design and execution of the study are an unlikely explanation for the failure to find an excess suicide risk among deployed veterans compared with nondeployed veteran peers. To minimize statistical variation due to sampling, the study included all 1.3 million former active component troops. Given the large number of study subjects and as many as 9 years of follow-up, the statistical power of the study would be about 80% to detect a 10% increase and over 95% to detect a 20% increase in suicide rate among deployed veterans relative to nondeployed veterans [38].

The interpretation of the study finding of no association between war zone deployment and suicide risk is somewhat attenuated by the possibility that military personnel who were ill or recovering from major surgery and who were determined to have psychological or behavior factors that excluded them from deployment would not have been deployed to Iraq or Afghanistan. How much this potential selection bias contributed to our failure to detect an excess suicide among deployed veterans is unknown. Also, both the U.S. Department of Defense and the VA offer more medical screening, counseling, and treatment programs to the deployed individuals than nondeployed, which may have had a positive effect in reducing the risk among the deployed veterans as a group.

Our reliance on death certificates rather than medical records for information on causes of death could be another possible limitation. The accuracy of cause of death recorded in the certificates is

variable depending on underlying cause of death. However, the agreement between medical records and death certificates was reported to be good for external causes of death [39]. The small but possible misclassification of suicide death would have been applied to deaths from both veteran cohorts as well as the US general population statistics because all three groups' cause of death information was derived from official death certificates.

In summary, both deployed and nondeployed veterans exhibit significantly higher suicide risk compared with the US general population. However, a history of deployment to the Iraq or Afghanistan war was not associated with the excess suicide risk among veterans. Considering the possibility that the psychological effect of war zone deployment may yet be manifested in later years by increased suicide risk among the deployed, a longer-term follow-up study of these individuals is warranted.

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References

[1] Department of the Army. Health promotion, risk reduction, and suicide prevention report. Washington, DC: Department of the Army; 2010.
[2] Rothberg JM, Bartone PJ, Holloway HC, Marlow DH. Life and death in the US Army in corpore sano. JAMA 1990;264:2241–4.
[3] Helmkamp JC. Suicides in the military: 1980-1992. Mil Med 1995;160:45–50.
[4] Kang HK, Bullman TA. Mortality among US veterans of the Persian Gulf War. N Engl J Med 1996;335:1498–504.
[5] Kang HK, Bullman TA. Is there epidemic of suicides among current and former US military personnel? Ann Epidemiol 2009;19:757–60.
[6] Spelman JF, Hunt SC, Seal KH, Burgo-Black L. Post deployment care for returning combat veterans. J Gen Intern Med 2012;27:1200–9.
[7] Street AE, Vogt D, Dutra L. A new generation of women veterans: stressors faced by women deployed to Iraq and Afghanistan. Clin Psychol Rev 2009;29:685–94.
[8] Department of Defense Task Force on the Prevention of Suicide by Members of the Armed Forces. The challenge and the promise: strengthening the force, preventing suicides, and saving lives. Washington, DC: Department of Defense; 2010.
[9] LeardMann CA, Powell TM, Smith TC, Bell MR, Smith B, Boyko EJ, et al. Risk factors associated with suicide in current and former US military personnel. JAMA 2013;310:496–506.
[10] Schoenbaum M, Kessler RC, Gilman SE, Colpe LJ, Heeringa SG, Stein MB, et al. Predictors of suicide and accident death in the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS). JAMA Psychiatry 2014;71:493–503.
[11] Ilgen MA, McCarthy JE, Ignacio RV, Bohnert AS, Valenstein M, Blow FC, et al. Psychopathology, Iraq and Afghanistan service, and suicide among Veterans Health Administration patients. J Consult Clin Psychol 2012;80:323–30.
[12] Hoge CW, Auchterlonie JL, Milliken CS. Mental health problems, use of mental health services and attrition from military service after returning from deployment to Iraq or Afghanistan. JAMA 2006;295:1023–32.
[13] Hoge CW, Castro CA, Messner SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. N Engl J Med 2004;351:13–22.
[14] Milliken CS, Auchterlonie JL, Hoge CW. Longitudinal assessment of mental health problems among active and reserve component soldiers returning from the Iraq war. JAMA 2007;298:2141–8.
[15] Kang HK, Hyams KC. Mental health care needs among recent war veterans. N Engl J Med 2005;352:1289.
[16] Ramshaw HJ, Fullerton CS, Mash HB, Ng TH, Kessler RC, Stein MB, et al. Risk for suicidal behaviors associated with PTSD, depression, and their comorbidity in the U.S. Army. J Affect Disord 2014;161:116–22.
[17] Debeer BB, Kimbrel NA, Meyer EC, Gulliver SB, Morissette SB. Combined PTSD and depressive symptoms interact with post-deployment social support to predict suicidal ideation in Operation Enduring Freedom and Operation Iraqi Freedom veterans. Psychiatry Res 2014;216:357–62.
[18] Pompili M, Sher L, Serafini G, Forte A, Innamorati M, Dominici G, et al. Post-traumatic stress disorder and suicide risk among veterans: a literature review. J Nerv Ment Dis 2013;201:802–12.
[19] Jakupcak M, Cook J, Imel Z, Fontana A, Rosenheck R, McFall M. Posttraumatic stress disorder as a risk factor for suicidal ideation in Iraq and Afghanistan War veterans. J Trauma Stress 2009;22:303–6.
[20] National Center for Health Statistics (NCHS). National death index user's guide. Hyattsville, MD: Centers for Disease Control and Prevention, NCHS; 2013.
[21] World Health Organization (WHO). International Classification of Diseases. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. Ninth Revision. Vol 1. Geneva, Switzerland: World Health Organization; 1977.
[22] World Health Organization (WHO). International Statistical Classification of Diseases and Related Health Problems. Tenth Revision. Geneva, Switzerland: World Health Organization; 1992.
[23] Schubauer-Berigan MK, Hein MJ, Raudabaugh WM, Ruder AM, Silver SR, Spaeth S, et al. Update of the NIOSH life table analysis system: a person-years analysis program for the windows computing environment. Am J Ind Med 2011;54:915–24.
[24] SAS Institute Inc.. SAS/STAT® 9.3 User's Guide. Cary, NC: SAS Institute Inc.; 2011.
[25] Armitage P. Tests for linear trends in proportions and frequencies. Biometrics 1955;11:375–86.
[26] Watanabe KK, Kang HK. Military service in Vietnam and the risk of death from trauma and selected cancer. Ann Epidemiol 1995;5:407–12.
[27] Boehmer T, Flanders D, McGeehin M, Boyle C, Barrett DH. Postservice mortality in Vietnam veterans: 30 year follow-up. Arch Intern Med 2004;164:1908–16.
[28] Writer JW, DeFraites RF, Brundage JF. Comparative mortality among US military personnel in the Persian Gulf region and worldwide during Operations Desert Shield and Desert Storm. JAMA 1996;275:118–21.
[29] Kang HK, Bullman TA. The risk of suicide among U.S. veterans after returning from Iraq or Afghanistan war zones. JAMA 2008;300:652–3.
[30] Kaplan MS, Huguet N, McFarland BH, Newsom JT. Suicide among male veterans: a prospective population-based study. J Epidemiol Community Health 2007;61:619–24.
[31] McFarland BH, Kaplan MS, Huguet N. Self-inflicted deaths among women with U.S. military service: a hidden epidemic? Psychiatr Serv 2010;61:1177.
[32] Kang HK, Natelson BH, Mahan CM, Lee KY, Murphy FM. Post-traumatic stress disorder and chronic fatigue syndrome-like illness among Gulf War veterans: a population based survey of 30,000 veterans. Am J Epidemiol 2003;157:141–8.
[33] Boscarino JA. Posttraumatic stress disorder and mortality among US Army veterans 30 years after military service. Ann Epidemiol 2006;16:248–56.
[34] Bullman TA, Kang HK. Posttraumatic stress disorder and the risk of traumatic deaths among Vietnam veterans. J Nerv Ment Dis 1994;182:604–10.
[35] Freeman TW, Roca V, Moore WM. A comparison of chronic combat related posttraumatic stress disorder (PTSD) patients with and without a history of suicide attempt. J Nerv Ment Dis 2000;188:460.
[36] Conner KR, Bossarte RM, He H, Arora J, Lu N, Tu XM, et al. Posttraumatic stress disorder and suicide in 5.9 million individuals receiving care in the veterans health administration health system. J Affect Disord 2014;166:1–5.
[37] Krysinska K, Lester D. Post-traumatic stress disorder and suicide risk: a systematic review. Arch Suicide Res 2010;14:1–23.
[38] Schlesselman JJ. Sample size requirements in cohort and case-control studies of diseases. Am J Epidemiol 1974;99:381–4.
[39] The Centers for Disease Control Vietnam Experience Study. Postservice mortality among Vietnam veterans. JAMA 1987;257:790–5.